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Final Letter Report

A CONCEPT FOR THE U.S. ARMY COMMUNICATIONS-ELECTRONICS ENGINEERING INSTALLATION AGENCY'S OPERATIONAL ELECTROMAGNETIC COMPATIBILITY PROGRAM

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Prepared for:

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Installation Agency
U.S. Army Strategic Communications Command
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Stanford Research Institute (SRI) was tasked to undertake a brief but intensive study to assist the U.S. Army Communications-Electronics Engineering Installation Agency (USACEEIA) of the U.S. Army Strategic Communications Command (USASTRATCOM) in the evaluation of CEEIA's responsibilities in STRATCOM's electromagnetic compatibility program (EMCP). Specifically, SRI was asked to assist CEEIA in developing a concept and philosophy of use for field measurement instrumentation to be used in discharging CEEIA's responsibility for EMC measurements for STRATCOM as well as in discharging STRATCOM's

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20 ABSTRACT (Continued)

Army-wide responsibility for operational EMC. This report summarizes the results of this brief study.

The effort included the following tasks:

- Requirements Analysis-with particular emphasis on field survey and data collection/evaluation aspects of the EMCP
- Concept and Philosophy Development--with consideration of the types and length of measurement; major systems, activities and geographical areas; measurement equipment requirements including frequency coverage and deployability; environmental operating restrictions; and data acquisition and distribution.
- Preliminary Functional System Design--with particular emphasis on any direct consequences of t[illegible] philosophy concept.

It was requested that SRI's main effort be [illegible] on requirements analysis and concept formulation. Work on the functional system design was to be general and to be consistent with the concept evolved from the analysis of requirements. To accomplish this work it was necessary to:

- Develop an understanding of CEEIA's mission in EMC as defined in Department of Defense (DOD) Directive 3222.3, pertinent Army Regulations (ARs), and the implementation plan for STRATCOM's EMC program.
- Supplement that understanding by discussion with CEEIA personnel and review of various CEEIA-generated material.
- Translate our understanding of CEEIA's EMC mission (Section III) into an initial set of objectives and general requirements (Section IV).
- Define specific requirements for an EMC measurement and analysis capability consistent with our understanding of the general requirements (Section V).
- Develop a concept for a field measurement capability to meet the requirements (Section VI).

In the process of performing these tasks we developed some preliminary ideas regarding a possible implementation concept for CEEIA in the EMC area; these ideas are summarized in Section VII. Recommendations are given in Section VIII. A summary of our conclusions and recommendations is given in the following section (Section II).

PREFACE

This report is submitted in response to a request by the U.S. Army Communications-Electronics Engineering Installation Agency (USACEEIA) for assistance in the evaluation of specific agency responsibilities for operational electromagnetic compatibility (e.g., radio frequency interference and hazard problems, field surveys, etc.) in the Army's electromagnetic compatibility program (EMCP).

Owing to the limited time available in which to study the CEEIA requirements, we could not formulate and evaluate numerous alternative concepts for the use of field instrumentation to meet these requirements. However, based upon knowledge gained during an eighteen-month study for the Office of Telecommunications Policy (OTP),* we synthesized the most reasonable concept consistent with our understanding of CEEIA's EMC measurement and evaluation mission. We believe that in this report we have formulated a basic framework useful to CEEIA in planning how to discharge its EMCP responsibilities for field survey and EMC problem solving measurements and analysis.

* "A Spectrum Measurement/Monitoring Capability for the Federal Government," by G. H. Hagn et al., dated May 1971 (Ref. 6). A copy of this document has been provided to CEEIA Headquarters.

CONTENTS

ACKNOWLEDGMENT

It is the authors' privilege to acknowledge the assistance of LTC C. E. McKnight, Mr. J. A. Levenstein, and Capt. D. M. Schreiner of the USACEEIA Program Management Office. The study would not have been possible without their active support during the course of the project. Valuable inputs also were provided by personnel from the CEEIA Communications Engineering Directorate and CEEIA-Western Hemisphere.

I INTRODUCTION

Stanford Research Institute (SRI) was tasked[*] to undertake a brief but intensive study to assist the U.S. Army Communications-Electronics Engineering Installation Agency (USACEEIA) of the U.S. Army Strategic Communications Command (USASTRATCOM) in the evaluation of CEEIA's responsibilities in STRATCOM's electromagnetic compatibility program (EMCP). Specifically, SRI was asked to assist CEEIA in developing a concept and philosophy of use for field measurement instrumentation to be used in discharging CEEIA's responsibility for EMC measurements for STRATCOM as well as in discharging STRATCOM's Army-wide responsibility for operational EMC. This report summarizes the results of this brief study.

The effort included the following tasks:[†]

- Requirements Analysis--with particular emphasis on field survey and data collection/evaluation aspects of the EMCP.
- Concept and Philosophy Development--with consideration of the types and length of measurement; major systems, activities and geographical areas; measurement equipment requirements including frequency coverage and deployability; environmental operating restrictions; and data acquisition and distribution.
- Preliminary Functional System Design--with particular emphasis on any direct consequences of the philosophy and concept.

It was requested that SRI's main effort be spent on requirements analysis and concept formulation. Work on the functional system design was to be general and to be consistent with the concept evolved from the analysis of requirements. To accomplish the work it was necessary to:

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[*] The tasking for this effort was accomplished under a Basic Ordering Agreement with STRATCOM, Contract No. DAEA18-71-A-0204.

[†] The statement of work for this task is included as an appendix.

- Develop an understanding of CEEIA's mission in EMC as defined in Department of Defense (DoD) Directive 3222.3,[1*] pertinent Army Regulations (ARs),[2-4] and the implementation plan for STRATCOM's EMC program.[5]
- Supplement that understanding by discussion with CEEIA personnel and review of various CEEIA-generated material.
- Translate our understanding of CEEIA's EMC mission (Section III) into an initial set of objectives and general requirements (Section IV).
- Define specific requirements for an EMC measurement and analysis capability consistent with our understanding of the general requirements (Section V).
- Develop a concept for a field measurement capability to meet the requirements (Section VI).

In the process of performing these tasks we developed some preliminary ideas regarding a possible implementation concept for CEEIA in the EMC area; these ideas are summarized in Section VII. Recommendations are given in Section VIII. A summary of our conclusions and recommendations is given in the following section (Section II).

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* References are given at the end of this report.

II SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based upon our current understanding of CEEIA's mission objectives within the context of the DoD, Army and STRATCOM electromagnetic compatibility programs.

A. Summary of Conclusions

1. CEEIA was recently directed by STRATCOM Headquarters (March 1971) to perform routine as well as quick response measurements,[5] but to date the vast majority of the CEEIA operational EMC work has been quick response (on a case-by-case basis).

2. Data on past requests for measurement and analysis services are available but they have not yet been synthesized into aggregate requirements. Nevertheless, after reviewing some of the past work, it is evident that many tasks currently performed by CEEIA on a quick response basis can be performed on a routine basis given effective scheduling and priority.

3. A definitive concept of the new CEEIA mission and requirements has not yet been formulated by CEEIA, although work toward concept definition has begun.

4. Some organizational problems exist for control of the current CEEIA EMC mission, and these problems will be amplified by the additional requirement for a routine survey capability.

5. Direct interfaces between CEEIA and many of the other members of the EMC community have been limited.

6. Equipment required to perform the routine measurement task is currently not available at CEEIA and the actual requirements/specifications for such equipments are incompletely defined.

7. CEEIA appears to lack easily operable and fully capable quick response equipment packages.

8. The current EMC data base at CEEIA is inadequate for the planning of new survey requirements.

B. <u>Summary of Recommendations</u>

From the results of this study the following recommendations are made (for a more detailed listing of the recommendations summarized here refer to Section VIII):

1. Analyze past, current, and anticipated requests for CEEIA assistance on EMC problems--as well as determine the characteristics of current and planned C-E equipments--to help establish the requirements for equipment, analyses, and personnel needed to satisfy the modified CEEIA operational EMC mission (see Section IV-D, IV-F, VI-B, and VII).

2. Specify a measurement system with some degree of automation which is consistent with the requirements for routine measurements and which is also capable of performing the quick response function. Plan for initial automation of only a few key functions with a capability (modular design) for expansion if required at some future time. A distinction should be made between mandatory requirements for field survey equipment and desirable but optional characteristics (see Sections VI-B and VII-A).

3. Specify analysis and data base requirements for both routine survey and quick response operations. Determine availability of support for these functions from other members of EMC community <u>and subsequently build CEEIA capability only as required</u> (see Sections VI-B and VII).

4. Establish CEEIA plans to accomplish the CEEIA portion of the EMCP. These should include both short- and long-range plans with the following elements: management, operations, equipment, analysis, educational training, data base, and interfaces (see Sections VI-A and VII).

5. Determine inadequacies of current equipment used for quick response capability and upgrade as required with light-weight, versatile, and easily transportable and deployable components (see Sections IV-B and VI-B).

6. Maintain an ongoing technical and management review of CEEIA tasks (the input and output) to accurately assess both the quality of CEEIA products and the need for modifying CEEIA plans (see Sections IV-C, IV-F, V-D, VI-A, and VII).

III THE FOUNDATION FOR THE CEEIA EMC MISSION

The purpose of this section is to summarize our understanding of CEEIA's EMC mission objectives as a preamble to requirement definition and analysis. A review of the following documents forms the basis of this understanding:

- DoD Directive No. 3222.3, "DoD EMCP" (5 July 1967)[1]
- Army Regulation AR 10-13, "STRATCOM Organization and Function" (23 November 1971)[3]
- Army Regulation AR 11-13, "Army EMCP" (29 July 1969)[2]
- Supplement 1 to Army Regulation AR 11-13, "STRATCOM Supplement to Army EMCP" (5 June 1970)[4]
- "EMC Plan for Implementation of STRATCOM EMCP" (March 1971).[5]

DoD Directive 3222.3 defines EMC as "the ability of communications-electronics (C-E) equipment, subsystems and systems to operate in their intended operational environments without <u>suffering</u> or <u>causing</u> unacceptable degradation because of unintentional electromagnetic radiation or response. It does not involve a separate branch of engineering but directs attention to improvement of electrical and electronic engineering knowledge and techniques to include all aspects of electromagnetic effects." This directive further makes the distinction between design compatibility and operational compatibility:

- "<u>Design Compatibility</u> is EMC achieved by incorporation of engineering characteristics or features in all electromagnetic radiating and receiving equipments (including antennas) in order to eliminate or reject undesired signals, either self generated or external, and enhance operating capabilities in the presence of natural or man-made electromagnetic noise.
- <u>Operational Compatibility</u> is EMC achieved by the application of C-E equipment flexibility to ensure interference-free operation in homogeneous or heterogeneous environments of C-E equipments. It involves the application of sound frequency management and clear concepts and doctrines to maximize operational effectiveness. It relies heavily on initial achievement of design compatibility."

The objectives of the DoD EMCP are:

- "Achievement of electromagnetic compatibility of all electronic and electrical equipments, subsystems and systems, produced and operated by components of the Department of Defense, in any electromagnetic environment. Operational compatibility is part of and the paramount focus of, this objective.*
- Attainment of built-in design compatibility rather than use of after-the-fact remedial measures.
- Fostering of common DoD-wide philosophies, approaches, and techniques in the design, production, test, and operation of C-E equipments."

EMC program areas designed to meet the above objectives are defined in DoD Directive 3222.3:

- Standards and Specifications
- Measurement Techniques and Instrumentation
- Education for EMC
- Data Base and Analysis Capability
- Design
- Concepts and Doctrine
- Operational Problems
- Test and Validation.

These program areas and the DoD elements responsible for each area are discussed in the context of interface requirements (Section IV-D).

The Army was assigned specific program area responsibilies in the DoD EMCP in the directive (Measurement Techniques and Instrumentation, and Test and Validation), but the Army also has general responsibilites in the DoD EMCP. To properly discharge its overall EMC responsibilities, the Army generated its own EMCP (AR 11-13).[2] This plan assigned overall responsibility for the Army EMCP to the Assistant Chief of Staff for Communications-Electronics (ACSC-E).† Other Department of the Army (DA) Headquarters

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* The Army-wide mission for operational EMC is assigned to CEEIA, as will be discussed later in this section. (Authors' underline.)

† Within ACSC-E, the responsibility for the Army EMCP has been delegated to the Electronics Directorate.

elements specifically requested to coordinate with ACSC-E are ACS for Logistics, ACS for Force Development, and the Chief for Research and Development. These other elements are also requested to ensure that the Army EMCP receives the proper program.

The two major subcategories of EMC are assigned, in AR 11-13 to major DA commands:*

- Design--U.S. Army Materiel Command (AMC)
- Operational--U.S. Army Strategic Communications Command (STRATCOM).

The responsibilities of the STRATCOM Commanding General (CG), as stated in AR 11-13 (Section 2-5), include:

- "Developing, maintaining and executing plans for the operational electromagnetic compatibility program area.
- Implementing and supervising electromagnetic compability control provisions applicable to USASTRATCOM C-E developments and operations.
- Ensuring that STARCOM plans include provisions for the Army EMCP Operational EMC program area and advising ACSC-E annually of such provisions as are made.
- Assisting CG, USCONARC, CG, USAMC, and CG, USACDC in discharging assigned program area responsibilities as required."

Other specific EMC-related functions of STRATCOM are given in Section 4 of AR 10-13:

> "b. For extension DCS (Army) systems, perform systems planning and engineering, and install such systems. Perform, in addition to functions cited in a above, functions including but not limited to, transmission engineering, associated site selection, <u>electronic environment surveys</u>,† and determination of facility, power, and other construction requirements including those pertaining to site acquisition, equipment selection, and preparation of technical specifications.

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* Other major DA Commands are assigned responsibilities:
- EMC concepts and doctrines--Combat Development Command (CDC)
- Develop and implement an EMC training program--Continental Army Command (CONARC)
- EMC Control during development--AMC
- Support of all programs pertinent to Army Security Mission--Army Security Agency (ASA).

† Authors' underline.

i. Engineer and operate radio frequency monitoring facilities to support DA frequency management activities as assigned; and conduct field spectrum measurements and radio frequency interference, radio frequency hazard, and radio propagation path surveys.

s. Perform onsite user test and evaluation to ensure compliance with Defense Communications Agency (DCA) (engineering and installations) standards prior to final acceptance of communications equipment and systems utilized for DCS (Army) purposes."

Item 4.s. pertains to quality assurance, but while it is a part of CEEIA's mission (Test and Evaluation Directorate) it is not treated further in this report.* The portion of item 4.b addressed in this report is electronic environment surveys. All aspects of item 4.i are germane to our analysis, but the primary emphasis is on RFI/RFH surveys and providing inputs to DA frequency management activities.

The details of STRATCOM's responsibilities in the Army EMCP are defined in STRATCOM Supplement 1 to AR 11-13 dated 5 June 1970.[4] One of the more significant responsibilities is assigned to DCS Plans and Operations:

"The DCS Plans and Operations [STRATCOM] Headquarters, will develop, maintain, and supervise the Electromagnetic Compatibility Program (EMCP) area, to include:

- Establishing and maintaining a frequency coordinating office.
- Identifying, annually, resources required to accomplish the STRATCOM EMC mission.
- Developing a quick reaction EMC problem reporting system.
- Coordinating with and assisting other Department of the Army EMCP area managers.
- Performing system analysis and studies relative to USASTRATCOM communications-electronics (C-E) development programs to ensure the C-E materiel does not generate EMC problems.
- Developing the USASTRATCOM plan for the EMCP."

A major CEEIA responsibility for EMC stems from the addition to paragraph 2-5 a(2):

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* The CEEIA Test and Evaluation Directorate (TED) is tasked primarily for quality assurance related matters [e.g., EMC acceptance testing, review of specifications, etc. as described in supplement to paragraph 2-5a (3)] which are not within the scope of this report. The TED also is asked to participate, as tasked, in the solution of operational EMC problems from analysis phase through complete corrective action phase of the project. This latter responsibility overlaps the responsibility of the CED, and implies the need for strong CEEIA management regarding the match between EMC problem requests and the allocation of CEEIA resources toward problem solutions.

"The Director, Communications Engineering Directorate [CED], Headquarters [STRATCOM], will provide technical and administrative support for the STRATCOM EMCP area, to include:

- Developing a quick reaction capability to analyze operational EMC problems.
- Developing procedures for applying existing measurement and analysis techniques to solve operational EMC problems.
- Conducting EMC evaluations of C-E systems to determine the effect of field environments.
- Participating, as tasked, in the solution of EMC problems from analysis phase through completed corrective action phase of the project.
- Identifying resources required for detecting and coordinating the solution to EMC problems.
- Submitting quarterly status reports on EMCP activities to DCS Plans and Operations, this headquarters.
- Providing annual program and budget input to DCS Plans and Operations, this headquarters."

At this point, it is appropriate to refer again to the DoD Directive 3222.3 for the frame of reference for an operational EMC plan within which CEEIA's mission fits before considering the EMC plan for implementing the STRATCOM EMCP.[5] The directive defines operational EMC problems as follows:

"Development of a capability for detecting, reporting, solving and correcting current time frame operational EMC problems [which] will require:

- Procedures for detecting and channels for reporting electromagnetic incompatibilities which degrade combat effectiveness in the field.
- Application of existing measurement and analysis techniques to identify the sources of the problems and determine corrective action.
- Procedures for rapid implementation of required corrective action."

The Army EMCP (AR 11-13, paragraph 3-10) summarizes the Army operational EMC program as follows:

"3-10 a. Capabilities will be developed under this program area for detecting, reporting, and coordinating the solution and correction of current operational electromagnetic compatibility problems. The development of a quick reaction capability will be given primary emphasis in all:

(1) Procedures for detecting and channels for reporting electromagnetic incompatibilities which degrade combat effectiveness in the field.

(2) Applications of existing measurement and analysis techniques in identifying problem sources and determining corrective action.

(3) Procedures for rapid implementation of required corrective action.

3.10 b. Electromagnetic compatibility measurements in operational C-E environments will be conducted under this program area."

A reasonable interpretation of this program leads to the general requirement for a quick response (QR) capability (paragraph 3-10 a) and for a routine survey capability (paragraph 3-10 b). We will return to the definition of these general requirements in Section IV-A of this report.

Reference 5 is the implementation plan for the STRATCOM EMCP. This document specifies the functions and responsibilities of all STRATCOM command and staff elements required to implement the STRATCOM EMCP. The division of tasks between STRATCOM Headquarters and CEEIA and our understanding of the major current responsibilities for these tasks are as follows:

"HQ USASTRATCOM is responsible for developing, implementing, maintaining and supervising the USASTRATCOM EMCP to include:

Establishing and maintaining a frequency coordination and utilization office [DCS Plans and Operations]

Performing system analysis and studies relative to USASTRATCOM C-E materiel development programs to ensure that C-E material does not create EMC problems when fielded [ACS for Force Development]

Identifying, annually, resources required to accomplish the USASTRATCOM EMCP mission [Comptroller]

Coordinating with and assisting other Department of the Army EMCP area managers as required [ACS for Force Development]

Logistical support required to accomplish the USASTRATCOM EMCP mission [ACS for Logistics]

Personnel, training and safety support required to accomplish the USASTRATCOM EMCP mission [ACS for Personnel and ACS for Force Development]

Establishing and maintaining contact with other government agencies, industry and educational institutions for the purpose of remaining abreast of the state-of-the-art in all cognizant areas of interest [ACS for Force Development]

Developing and maintaining the USASTRATCOM EMCP Plan [ACS for Force Development].

U.S. Army Communications-Electronics Engineering and Installation Agency (USACEEIA) is responsible for EMC field engineering support and C-E materiel quality assurance, to include:

Developing a routine as well as a quick reaction capability to analyze operational EMC problems [CEEIA Headquarters]

Identifying the need for and defining requirements for new EMC instrumentation and measurement techniques and procedures [TED, CED, CEEIA-Western Hemisphere]

Developing procedures for applying existing measurement and analysis techniques required to solve EMC problems [CED, CEEIA-WH]

Conducting EMC evaluations to determine the extent to which C-E materiel impacts the electromagnetic spectrum [CED, CEEIA-WH, PMD--also DCS Plans and Operations]

Reviewing C-E materiel specifications, work statements, material requirements documents and other technical procurement documents from a quality assurance viewpoint to ensure that EMC provisions are presented in meaningful qualitative and quantitative terms and are consistent with the intended application [TED]

Conducting EMC acceptance testing on USASTRATCOM procured C-E equipment and installations [TED]

Planning, programming, and budgeting input to the EMC program annually [PMO and other elements]

Establishing and maintaining contact with other government agencies, industry and educational institutions for the purpose of remaining abreast of the state-of-the-art in all cognizant areas of interest [all EMC-related CEEIA elements]."

Note that the first item under CEEIA's responsibilities is the development of a routine as well as a quick reaction capability. This particular mission objective will be treated in more detail throughout the remainder of this report, with particular emphasis on the field survey and data collection/evaluation aspects.

IV GENERAL REQUIREMENTS

A. Introductory Remarks

In the previous section, the general CEEIA mission and its place in the overall EMCP were discussed. In this section, the general requirements the EMCP places on CEEIA are discussed. Section V, following, describes the specific requirements the EMCP places on CEEIA.

Currently, operational EMC problems are identified by personnel at specific facilities and are subsequently forwarded through chains of command to CEEIA. Added to the present tasks of quick response RFI/RFH measurements and occasional site surveys are the following general tasks (see Section III):

- Routine surveys of sites to establish EMC data base elements and provide preventive EMC maintenance.
- Confirmation of EMC specifications in a field environment.
- Establishment of data base elements and maintenance of adequate data base for EMC problem anticipation and problem solutions (not necessarily at CEEIA).
- Development of data base and planning interfaces with other DoD elements to ensure optimum utilization of CEEIA-generated data and optimum response of CEEIA to measurement requirements.
- Increased postmeasurement analysis to provide data for frequency assignments, system compatibilities, problem prevention, etc.
- Maintenance of state-of-the-art contacts with other organizations (government and private) to ensure use (as required) of latest equipments and techniques.

The addition of these tasks to the current CEEIA tasking means that the overall CEEIA operational doctrine would evolve from their current "brush fire" mode to a preventive maintenance/brush fire mode. The incorporation of a routine survey requirement--with its attendant increase in available data base, increased use of available data and analysis tools, reduction in

potential problems, increased life cycle system control, etc.--into the CEEIA operation will gradually reduce the brush fire requirement to some irreducible minimum.

To accomplish this objective, CEEIA must change its character from an on-call troubleshooter to an active participant in the development of an effective operational EMC program. This change, which is essentially caused by a greatly expanded operational requirement, leads to the following general requirements:

- Operational Doctrine which will decrease the brush fire requirement through effective scheduling (based on a to-be-developed priority scheme) of routine surveys.
- Organizational Structure designed to support multiple measurement teams--both scheduled and brush fire--in world-wide field operations as well as establishing multiple interfaces with the EMC community.
- Interfaces with other elements of the EMCP to determine their requirements for data, establish CEEIA needs for analysis facilities, identify data base elements, determine demands for CEEIA data, establish time perishability of data and analysis requirements, etc.
- Education in the EMCP will be a crucial part of the CEEIA mission because the program provides a unique opportunity to interact with field personnel in the identification and resolution of EMC problems. Internal education of CEEIA technical, management, and analysis personnel is a clear part of the educational process required.

The general requirements will be jointly developed by CEEIA, other members of the EMC community, and facility commanders to assure that the goal addressed by AR 11-13--"The solution of operational problems will be addressed within the EMCP as first priority"--is achieved.

B. Definition of Routine and Quick Response

Routine and quick response (QR) measurements have been identified in Section III as a required part of CEEIA's mission in the Army EMCP. These terms will now be defined more explicitly as they are used in the remainder of this report.

1. Routine Measurements

Routine measurements are defined (for the purposes of this study) as a scheduled survey of priority-ranked sites. The objective of routine surveys are broad relative to what we will define as the objectives for QR measurements.

2. Quick Response Measurements of Analysis

The QR requirements will be those tasks which are primarily oriented toward the solution of a specific problem existing at a facility. These tasks are problem-oriented with rather limited objectives (i.e., solution of an immediate problem) and are not considered to be employed for general site documentation.

3. Discussion

In general, the purpose of routine measurements will be to acquire a comprehensive data base on a few critical parameters, whereas the exact measurements to be taken during a QR task will depend upon the type of problem and may involve taking data on a large number of parameters not normally measured during routine surveys. The critical parameters to be measured during routine surveys will be selected to identify most standard EMC problems and more comprehensive measurements can be made by the routine survey team if EMC problems are identified.

An example might further clarify the distinction between QR and routine. Consider a survey for updating a data base on the status of RFH sources. This would not be considered QR; whereas the detection, identification,

and recommendation for correction of a suspected RFH on an emergency time scale would be categorized as QR. Another distinction between QR and routine is that the need for routine measurements can be anticipated in a manner permitting active planning, while a request for QR assistance can only be met by reacting on a case-by-case basis.

C. Operational and Organizational Requirements

The current CEEIA operation and organization can be characterized as a responsive function to operational EMC problems. As such, it maintains an operational capability to quickly field small expert teams of measurement and engineering personnel whose function it is to identify EMC problem sources and recommend remedial action. In a sense, this is analogous to being on the leading edge of a wave, in which the current CEEIA EMC operations and organization are driven by external forces and need have only a capability to respond to those forces.

With the introduction of routine surveying to its requirements, however, CEEIA is now placed in the position of having to plan for the utilization of a greatly expanded capability to fulfill its obligations to the EMCP. We have not, unfortunately, been able to perform a rigorous analysis of the type of organizational and operational configurations that meet the revised CEEIA mandate. It is our belief that such a study is required and that it should include the following elements:

- Scope of CEEIA world-wide measurement commitments in the EMCP
- Scope of CEEIA requirements to provide central and regional organizational structure
- Alternative operational concepts and their impact on organizatational options
- Identification of total resources (equipment, manpower, logistics, funds, etc.) needed to meet EMCP requirements. This study should be performed for each of the various organizational and operational options.

Clearly, CEEIA's chain of command should be directly responsive to operational elements, and immediate planning to accomplish efficient and rapid reaction to operational EMC problems should be initiated.

D. Interface Requirements

The interface requirements are too numerous to address comprehensively in this report; however, several of the more significant ones will be covered in some detail.

First, let us consider the interface's within CEEIA itself. An important set of interfaces currently exists between the CEEIA Program Management Office (PMO), the Communications Engineering Directorate (CED), and the CEEIA-Western Hemisphere (WH).* These CEEIA components represent management, engineering, and technical support. It is essential that these interfaces be as direct as possible.

Next, let us identify important interfaces between CEEIA and the rest of STRATCOM. Regarding operational EMC, the most important interface is with STRATCOM Headquarters, who refers requests for action to CEEIA. This STRATCOM function has been delegated to ACS for Force Development (ACSFOR). Another important interface exists with the operational element of STRATCOM, DCS Plans and Operations. This interface can provide knowledge of operations pertinent to the solution of current EMC problems and identification of potential EMC problems. DCS Plans and Operations also contains as a subordinate responsibility the frequency coordination and utilization office, and CEEIA's interaction with this office is vital. Other important interfaces are ACSFOR (unit training), ACS for Logistics (transportation), and ACS for Personnel (acquisition and individual training).

As stated in DoD Directive No. 3222.3, the lead responsibility for EMC is divided by program areas:

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* The interface with the Test and Evaluation Directorate (TED) also is important, but it is not within the scope of our task to consider it further.

* Standards and Specifications--U.S. Navy (delegated to Naval Electronic Systems Command)
* Analysis Data Base and Analysis--U.S. Air Force (discharged primarily through ECAC, see DoD Directive 5160.57)
* Measurement Techniques and Instrumentation--U.S. Army (delegated to U.S. Army Electronics Command)
* Test and Validation--U.S. Army (delegated to the Army Materiel Command)
* Operational Problems--Joint Chiefs of Staff
* Design--Each DoD Component
* Education--Each DoD Component.

Interface with all of these program areas are useful.* The Most important interfaces for CEEIA probably are with ECAC and EMETF on analysis and data base, with ECOM on EMC design, measurement techniques and instrumentation with USAEPG on test and analysis (including models) and with Navy and Air Force groups on operational problems and spectrum monitoring.

It is also important for the CEEIA EMCP to interface with other programs:†

* Radiation Hazard Program (VII-B)
* Tempest Program (5-3)
* Electronic Countermeasures Program (VII-B, 5-3)
* Electronic Counter-Countermeasures Program (VII-B)
* Electromagnetic Pulse Program (VII-B)
* Army Nuclear Weapons Surety Program (5-3)
* Army Material Reliability and Maintainability Program (5-3)
* Meaconing, Intrusion, Jamming, and Interference (MIJI) Program (AR 105-3).

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* It is evident that any CEEIA interfaces must be accomplished through appropriate channels.

† The Roman numerals refer to the section of DoD Directive 3222.3; whereas the Arabic numerals refer to the section of AR 11-13.

Interfaces with other government agencies, industry (e.g., equipment manufacturers), independent research organizations (e.g., SRI, SwRI, etc.), technical associations (e.g., IEEE) are essential for keeping abreast of the state-of-the-art in areas related to EMC. Some joint groups such as the Joint Technical Advisory Council (JTAC) of the Institute of Electrical and Electronic Engineers (IEEE) and the Electronic Industries Association (EIA) are also valuable sources of technological progress. For example, the JTAC Sub-Committee 63.1 produced a most useful document, "Spectrum Engineering--The Key to Progress,"[7*] and JTAC Subcommittee 71.1 is currently studying the problem of man-made radio noise.

E. Educational Requirement

Education in EMC is essential. Among the many facets of EMC education, the ability to recognize an EMC problem and the ability to solve it are basic. According to DoD Directive 3222.3, all DoD components have responsibility for participation in the EMC education program area:

- "Ensuring that properly balanced emphasis on EMC is included in all formal courses in design, maintenance, and operation of C-E components, circuits, equipment subsystems, and systems conducted within their organization.
- Maintaining current handbooks describing the most effective techniques for meeting the Standards for EMC. Adoption of other DoD component handbooks which are adequate is encouraged.
- Ensuring adequate participation by appropriate members of their Department or Agency in the symposia, conference, and other professional activities of the industry organizations and technical societies concerned with EMC and complete electronic engineering."

There are several categories of educational requirements pertinent to CEEIA's EMC work:

- Education of CEEIA technical personnel regarding EMC analytical and measurement techniques

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* This reference provides an excellent source of information on the various subelements of the EMC community with whom CEEIA might profitably interface.

- Education of CEEIA management regarding EMC
- Education of the operational site personnel, particularly the base commander and his EMC officer but also the operations and maintenance personnel, regarding EMC problems while the CEEIA routine survey teams or QR teams are on-site.

The implementation plan for STRATCOM's EMCP[5] mentions the requirement for:

> "Establishing and maintaining contact with other government agencies, industry, and educational institutions for the purpose of remaining abreast of the state-of-the-art in all cognizant areas of interest."

F. Estimated Requirement for CEEIA Operational EMC Measurement Services

One approach to estimating the general requirement for CEEIA's EMC survey and problem-solving capability is to consider the major systems or activities to be served. The major customer probably will be STRATCOM, and CEEIA has a direct responsibility to service STRATCOM's needs. This will typically involve requests for assistance to that part of the Defense Communications System (DCS) for which the Army is responsible, but occasionally other parts of the DCS may request help. CEEIA has the responsibility for operational EMC Army-wide. Hence, other systems or activities to be served may include:

- Defense Civil Preparedness Agency (DCPA)
- Army Air Defense Command (ARADCOM)
- Continental Army Command (CONARC)
- Safeguard
- Satellite Communications Agency (SATCOMA)
- Other Army activities
- Other DoD activities
- Other Government activities

One method of acquiring data upon which to base an estimate for services is to ask these identified Army activities if they anticipate the need for assistance from CEEIA on EMC problems. CEEIA has made this request

and has begun to receive some replies.* There appears, however, to be a need to make CEEIA's availability for such work more widely known. Nevertheless, the chief factor which will determine the required size of the CEEIA effort will be the actual number of sites and types of measurements that must be made.

In FY 72, the number of requests for CEEIA EMC services totaled about 80. Initial estimates of the total number of sites that require routine surveys indicate that 120 to 150 sites may need surveys on some sort of periodic basis:† Typical estimates by area are as follows:

North America $\approx$ 50 sites

Central Europe $\approx$ 25 sites

Southern Europe $\approx$ 15 sites

Western Pacific $\approx$ 25 sites

Southeast Asia $\approx$ 25 sites.

It is probably realistic to assume that the routine periodic surveys will gradually reduce the number of requests for quick-response efforts so that for initial planning a horizon of a combined routine/quick-response requirement of 150 EMC measurements per year can be used.

On the basis of 150 EMC measurements per year and an average measurement time of one week per site, a total effort of 150 measurement-weeks is required. This is clearly well beyond CEEIA's current capability in equipment, manpower, and logistics by perhaps a factor of 5 or more. It is also clear that CEEIA will have to expand its analysis and data base

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* For example, on 29 June 1972, CEEIA received a request from Army Air Defense Command (ARADCOM) for EMC surveys of five ARADCOM sites each fiscal quarter to establish baseline radiation levels and plot increases over any previously established levels. A possibility of two additional EMC surveys was mentioned at sites which develop computed radiation levels above the limits established by ARADCOM regulations or at sites which acquire equipment modifications to increase radiated power.

† No detailed study of the geographical coverage requirement was made; however, some of the data required for such survey are available to CEEIA Headquarters.

capabilities by even larger factors since these capabilities currently exist in only a rudimentary state. As the CEEIA EMC capability evolves to meet the increased demand and its enhanced ability to resolve operational EMC problems becomes better known, it is probable that other Army areas will also utilize CEEIA services which will require still further expansion of its capabilities.

In summary, estimates based on our understanding of future CEEIA requirements indicate that an immediate planning horizon for a growth to 5 times its current size should be planned for in the measurement personnel areas with a growth (or even an initiation of capability) in the analysis and data base capability of about 10 times current capability. Such rapid growth requires careful planning for organization requirements. These requirements are addressed in detail in the remainder of this report.

G. An Approach to Problem Definition

Before discussing specific requirements it is appropriate to consider some of the factors pertinent to problem definition. During a recent study for the Office of Telecommunications Policy (OTP),[6] SRI defined the concept of a generalized measurement/monitoring scenario. The important variables that must be described to quantify a measurement/monitoring problem include radio systems, uses of monitoring data, and dimensions of the operation. In designing and employing a measurement/monitoring system (or systems), three primary dimensions will allow flexibility: frequency, space, and time, i.e., the measurement/monitoring system will have frequency range and bandwidth flexibility, can operate at a fixed point or on a line in space while in motion, and can monitor at a certain scan rate for a period of time. It is logical, therefore, to formalize the problem statement into these three dimensions. The term General Measurement/Monitoring Scenario (GMS) is a convenient one to use; it is defined as being a synthesis of the general characteristics of a measurement/monitoring requirement, having the dimensions of frequency, space, and time. The dimensioning of the GMS is discussed in detail in Appendix A of Ref. 6.

The first task of problem definition is problem identification. This task is currently performed by the commander of an operational base. An example will illustrate the sequence of steps required to translate a request to STRATCOM for assistance into a defined problem and plan (specific example scenario). The example will also illustrate one of the types of problems that lead to the requirement for an Army-wide operational EMC capability.

Consider the hypothetical case in which a new Army tactical headquarters has been established adjacent to an Air Force facility. No problems are encountered until the Army communications equipments are activated and serious co-site interference is observed on both the Army equipment and an Air Force radar. The specific cause of the interference is unclear. A request for assistance is routed to the STRATCOM and referred to CEEIA. The CEEIA operational EMC management translates the request into:

- Statement of work
- Specific scenario including:
  - Problem statement
  - Background information
  - Specification of required work (test plan): measurements required and necessary system configuration, data processing, and analyses.

The CEEIA personnel then coordinate with ECAC regarding available data and analysis. The CEEIA test team proceeds to the site and obtains data for resolution of the problem. Corelation of the field data with ECAC records reveals that the problem must be resolved at the joint-service level, and a recommendation regarding the technical aspects of the solution is made to STRATCOM Headquarters for forwarding to the appropriate organizations.

To better define the specific requirements it would be desirable to analyze actual past requests to STRATCOM for operational EMC assistance (rather than rely on hypothetical examples such as the one given above) and look for patterns as a function of:

- System type
- Geographical area
- Frequency band
- Site physical environment
- Co-site electromagnetic environment.

The types of problems should then be categorized to the extent practical. This analysis would not only yield a better understanding of specific requirements but it would also give additional insight into the categories of problems that are amenable to solution (or prevention) by routine surveys.

V SPECIFIC REQUIREMENTS

This section will discuss some of the specific requirements for the primary functions of the EMCP: measurement and testing, analysis, data base, and management.

A. Measurement and Testing

A number of measurements should be performed to provide data useful for EMC problem-solving. To improve measurement efficiency, while still acquiring an adequate data base, the number and type of measurements must be designed carefully to minimize the overall time on site. As discussed previously, these measurements can be divided into two broad categories: Routine Survey Requirements (RSR) and Quick Response Requirements (QRR).

1. Quick Response Requirements (QRR)

QRR are typical of those tasks performed in the past by CEEIA. These are normally measurements performed in response to a specifically defined EMC problem which affects personnel safety, ordnance, or which results in equipment malfunction or critical degradation of the ability of the system to perform its mission. QRR can thus be subgrouped into those involving a radio frequency hazard (RFH) and those involving radio frequency interference (RFI).

To resolve EMC problems involving RFH, it is necessary to have the following minimal capabilities:

- Signal detection
- Signal identification
- Source location
- Analysis.

These broad categories of capabilities first allow one to determine the presence of a hazardous signal and its peak and average power level in critical areas (or the capability to determine areas where hazardous or

near-hazardous powers are present). This information can be developed through analysis of emitter data related to the site under investigation as well as on-site measurements. Once the presence of an RFH has been detected, the source of RF energy must be identified and located through frequency measurement and direction-finding techniques along with analysis of known emitter information. After the RF source has been located, the field personnel must be capable of recommending practical means of reducing or eliminating the RFH through shielding, redesign, placement of barriers, or similar techniques. The measurement team must also be equipped with dosimeters and (or) RF detection badges to warn them if they are operating in a hazardous area.

The general classes of capabilities required to resolve RFI problems are similar to those outlined for RFH surveys, but refinements are required for RFI problem-solving applications. Since RFI problems frequently can be created with lower signal strengths than can RFH problems, signal detection instrumentation must be provided with increased sensitivities. It may also be necessary, in some cases, to have the capability to demodulate the interfering signal to properly identify it. Since RFI can be induced in a system both through radiation and direct coupling, additional sensors must be provided beyond those required for RFH measurements. In addition to antenna-type sensors, these sensors must include broadband and frequency-tunable voltage and current probes that can be directly coupled to suspect RFI coupling paths. The equipment must be configured so that it can be easily located within confined areas. To avoid introducing ground-loops by the measurement instrumentation, it is imperative that the option to operate the instrumentation on isolated (isolation transformers/filters or battery) power supplies be available and means be available to electrically isolate the coupling of the instrumentation to the system under test. Once the source and (or) coupling path of the RFI has been determined, the measurement team must have the capability to recommend means to resolve the RFI problem using such techniques as source elimination, shielding, grounding, and filtering.

To effectively resolve QRR problems, the instrumentation must be configured so that it can be easily separated into modules which can be hand-carried within a facility and easily shipped in the field. All QRR should be easily resolved with manually-operated equipment.

2. Routine Survey Requirements (RSR)

RSR will consist of a well-defined set of measurements to be performed at selected facilities. These measurements will provide an evaluation of the system EMC effectiveness measure, as well as provide information leading toward preventative maintenance measures. To perform the routine measurements the system must be capable of performing at least the basic functions cited for the QRR system, but it should also be able to perform rapid frequency scans and provide automatic data logging. The system must be capable of measuring and recording strong signals as well as an indication of the ambient noise level. Ideally, the system should be configured to minimize operator-machine difficulties and the probability of operator errors.

In addition to the actual measurement aspect of this task, it will also be necessary for the EMC team to make visual inspection of the facilities to detect existing or potential EMC problems and recommend corrective measures.

For either RFI or RFH measurements, RSR will be used primarily to document the site condition (signal and environment), as defined above, and system operation for both types of measurement will be relatively similar. Since RSR's will be performed on a scheduled basis and increased logistic support will be needed, the packaging and maneuverability constraints may be relaxed somewhat in relation to the QRR measurements system, but the system must be capable of being quickly disassembled (i.e., modular construction) to meet special deployment and shipment requirements. The routine survey must have the capability to be used in the QR mode.

3. Environmental Considerations

Because the CEEIA mission is world wide, the operational environment must be considered when selecting measurement equipment and its packaging. Protection against climatic conditions can be provided in most cases by operating equipment (except sensors and antennas which must withstand wind loading, lightning, etc.) within an environmentally controlled shelter, but it must be remembered that large shelters cannot be adapted to all measurement situations (e.g., many QRR).

In addition to the climatic environment, the electrical environment (RFI, RFH, EMI, and EMH) must be considered when specifying equipment packaging, shielding, and interconnection.

Special consideration must also be given to packaging of the instrumentation during transportation. Such factors as shock and vibration and large temperature and humidity variations must be considered when designing packaging and shelters for instrumentation shipment.

B. Analytical Requirements

A potential EMC problem that is referred to CEEIA will require the use of analytical tools from inception to completion. A problem or request for monitoring must initially be analyzed to determine if it requires a quick response, or a routine response. This initial determination will be made by CEEIA using available technical data bases, considerations of system/personnel availability, logistics, priority, and analysis tools. (Note that this determination is based, as are many others, on joint technical and management decisions.)

Within the two categories of quick response and routine response are three analysis subcategories: (1) premeasurement analysis, (2) on-site measurement analysis, and (3) postmeasurement analysis. The complexity of the analytic solution to presented problems and requirements is, on the other hand, less clearly defined and is dependent upon the availability of the required data base and analysis tools for each problem. In the remainder of this section, these analysis requirements are briefly discussed.

1. Quick Response Analysis

A problem that is input for resolution in the quick-fix mode is similar to those currently handled by CEEIA. An initial query of data base elements needed for quick-fix efforts (see next section) will be made to identify local emitters, new emitter installations, and site and signal and environment conditions as determined from routine surveys (or previous quick response efforts). Signatures on new emitters will be evaluated to determine the probabilities that they are causing the EMC problem (RFI, RFH) under study. This more detailed analytical analysis may also lead to an analytical solution. If an analytical response is not available these and other inputs from the analyst and (or) the field engineer will develop a test plan for solving the particular problem. This plan will include a description of measurement equipments (including any special equipment requirements) and strategy the field team will employ.

After arrival at the site, the field engineer will make a quick (on-site) analysis to confirm that the preliminary analysis of the input data accurately portrayed the actual situation. This measurement task will confirm the validity of the preanalysis and (or) identify areas where the preanalysis failed to accurately portray the EMC environment. Using the appropriate measurements, the field engineer will analyze and isolate the EMC problem and report the results to the base commander. Careful documentation (in predetermined data formats) of the perceived EMC situation will be used so that the CEEIA (and other user's) data base related to the site can be easily updated.

At CEEIA, Headquarters, the field engineer, with analyst help as required, will use available data analysis tools (such as propagation models, EMC models, and environment models) to make a postmeasurement analysis to confirm the accuracy of his on-site analysis. The final step of the process will be to report the results and make final recommendations.

2. Routine Response Analysis

The inclusion of a site in the routine monitoring program should include a preanalysis to establish a priority scheme for measurements. This

determination should be based on a combination of technical and management considerations such as site history (from an EMC standpoint), evolution of emitters in and around the site, input from quick response teams, site importance, and time since last measurement.

On-site analysis will include the quick-fix capability plus measurement validation, data logging, emitter changes, problem identification (current and (or) potential), training of site personnel in EMC analysis/problem recognition, etc. Measurement validation will permit system operators to confirm the preanalysis site environment and, if differences are determined, to identify their causes. These causes might be one of several EMC problems: for example, emitters not included in the site data base, radiators not complying with EMC specifications, and site installation practices. It can be expected that on-site analysis will identify some but not all of these problems.

It is important, therefore, that sufficient data be collected to permit postmeasurement analysis to identify all EMC problems, i.e., the data for each site must be carefully logged. This check on data logging will require on-site validation of the recorded data base prior to its shipment to the analysis center(s).

At the present time, it is recognized that many EMC problems are not easily identified by personnel not familiar with EMC analysis. Consequently, it is expected that the EMC team will identify EMC problems at many of the visited sites. These problems will be described by the team to the site commanders or designated personnel. In addition, the team should provide routine indoctrination of maintenance personnel in the identification and resolution of EMC problems.

Upon completion of the measurement/analysis of each site, the team will transmit the acquired data to the central analysis facility(s). Data copies should be retained in the system until confirmation of correct receipt is provided by the analysis center(s). Postmeasurement analysis will include the updating of data bases for the site. Any recommended EMC repairs will be subjected to further analysis (as required) and final recommendations for their implementation sent to the site commander.

The analysts should determine the condition of the EMC situation at the site and rate the need for future measurements based on technical and environmental factors. This rating should then be forwarded to management who will add management factors to the rating to establish the next logical monitoring team visit. This technique will permit dynamic and responsive scheduling of the EMC teams' efforts.

C. Data Base Requirements

In the previous section, the need for data in premeasurement, on-site measurement, and postmeasurement analyses was identified. In general, this data base should contain the following elements:

- Emitters by site and geographic location--this element will include technical and operational equipment parameters and changes in emitter situation.
- Signal situation as observed at site by past surveys.
- Environmental conditions including weather, terrain, man-made noise, power line proximity, and road proximity.
- Past history of EMC problems at sites.
- Signatures of C-E equipments that are installed, or that may be installed, in each site.
- EMC-related operational characteristics of C-E equipments, i.e., standards for radiation, susceptibility, tolerances, etc.

This data base must be available to CEEIA personnel during their analysis of operational EMC problems. CEEIA need not maintain the data base at headquarters, but CEEIA analysts must be able to access the data base from their headquarters. This requirement can, therefore, be met by (1) a data base maintained at CEEIA, (2) access through a teleprocessing system to the computer where the data base is maintained, or (3) a combination of these two options.

The detailed specification of the data base elements and their location in the EMC community can be determined as the CEEIA EMC program evolves. At present, it appears that the data base elements needed for preanalysis of quick reaction measurements should be instantly available to CEEIA analysts. To the extent that this requires that that data base be resident in the computer used by CEEIA, then a data base is required at CEEIA. The next most critical data element is data required for on-site analysis by the quick reaction team. If the reaction time of team is extremely fast (because of a serious problem), then that data base should also be rapidly available, i.e., probably resident in the CEEIA computer.

Some of the data elements, such as C-E equipment signatures, are more readily maintained at general DoD analysis facilities, such as ECAC, or U.S. Army Communication-Electronic Computer Application Agency (USACECAA) than at CEEIA. Since relatively few immediate requirements for such data are implicit in the CEEIA program, maintenance of these data at other locations is realistic.

In summary, based on currently available data, it appears that some segment of the data base should be maintained at the computer available to CEEIA while other data elements can be provided from other data bases on time schedules that vary from several hours to several days. If teleprocessing facilities cannot be made available (either for technical or cost reasons), then the total data base would have to be maintained in the CEEIA computer facility. An important consideration of the data base is that CEEIA must assume responsibility for the accuracy and currency of data elements that are collected and (or) analyzed by CEEIA.

D. Management Requirements

The complex nature of the operational concept--involving many problems, people, facilities and equipment operating world-wide--requires a well-defined, carefully-conceived management function. This function must perform the following:

- Interface with the EMC user to receive requests for service and output recommended solution

- Establish priorities for operational EMC problems
- Schedule resource allocation of the measurement, analysis, and data base functions
- Coordinate the activities of these functions
- Plan for future problems/activities
- Review performance to assure quality
- Interface with the rest of the EMC community.

The planning, scheduling, and coordination requirements will require particular emphasis if the CEEIA mission involving routine surveys is to be effectively carried out.

VI CEEIA EMCP CONCEPT DEFINITION AND DISCUSSION

A. General Concepts

1. Operational

A conceptual operation of the EMCP is shown in Figure 1. This does not represent an organization chart, but provides a display of the major operational subtasks required to process an EMC task submitted to the CEEIA.

As indicated at the top of Figure 1, a problem statement or request for analysis is received by HQ STRATCOM from agencies within STRATCOM or other organizations with EMC problems. This problem is directed to the CEEIA EMCP management group who will analyze the request and determine the approach to be employed to resolve the problem. There are three alternative approaches available to the CEEIA management group, as described in the following paragraphs.

In some cases, the CEEIA EMCP management group may determine that the request is not EMC related or that further information is required from the requestor to better understand the problem. In these situations, it will be necessary for the management group to coordinate through HQ STRATCOM to inform the requestor that the problem cannot be resolved within the CEEIA EMC group and to request further information or, possibly, suggest alternate available solutions (e.g., other DoD organizations or outside contractors).

If the management group determines that the task can be accomplished within CEEIA, two basic alternative approaches are available: quick response (QR) and routine surveys (RS). If a task is determined to be a QR requirement, it is first necessary for the QR group to determine what data are available in the data base which CEEIA can access that would be applicable and what models could be utilized to satisfy the requirement and request these data and models. Once the data and models have been acquired and reviewed, a decision must be made if a complete analytical solution exists. If this solution exists, the analytical group will reevaluate the data to

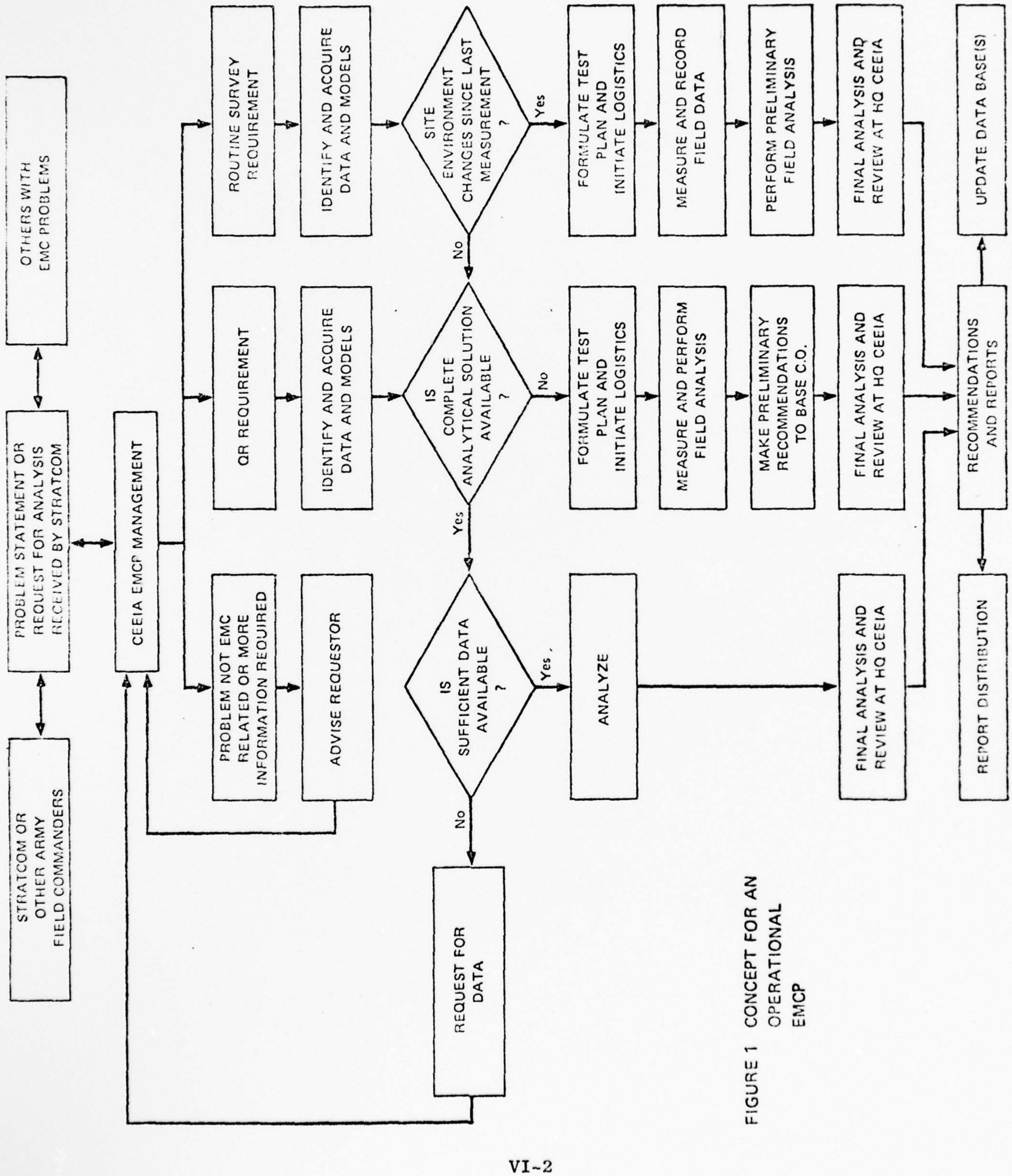

FIGURE 1 CONCEPT FOR AN OPERATIONAL EMCP

determine if they can analyze the problem completely. If insufficient data are available, the analytical group will request that measurements be performed to supply the required data and coordinate through the EMCP management group. If sufficient data are available, the analytical group will resolve the problem and provide their recommendations and reports.

If a QR is required and it is determined that further data are required, a test plan for measurements will be formulated, logistics will be arranged, and the measurement task will proceed in a fashion similar to that used in past EMC tasks at CEEIA.

When the management group determines that a RS is required, it will again be necessary to acquire applicable data and models which are available to CEEIA. These data will consist primarily of information from past routine surveys plus any additional information acquired since the last routine survey. Using the data, the survey group will determine any changes that may have occurred at the installation since their last survey so as to inform the measurement team of areas which may require more detailed information during the data acquisition phase. At this point, a test plan will be formulated, the measurements will be scheduled, and logistics arrangements will be made. After the measurements are completed, the field team will perform a preliminary review of the data to provide general recommendations to the personnel at the measured installation and return the data to HQ CEEIA for final analysis and review by CEEIA EMC management.

For any of the above tasks, it will be necessary for CEEIA to provide recommendations and a report describing the task and its results. It is important that these reports be distributed to the DoD EMC community and that any data derived from the task that appears to be of use in the future be distributed to the appropriate data bases so that it can be retrieved by CEEIA and other organizations in the future.

2. Organizational

A definitive statement on the organization of CEEIA to meet its redefined mission is clearly beyond the scope of this report. It is logical,

however, to begin with the organization as currently configured and pattern its evolution to more desirable organizational configurations.

A future organizational concept for CEEIA should be guided by their need to interface with the EMCP community and users of CEEIA services and their need to optimally respond to their mission. Our initial concept of an organization that can accomplish this is one that exercises central control over its assets and is directly responsive to the needs of its customers.

Such a concept derives from the following considerations:

- A minimal staff from which to begin expansion
- A need to evolve equipment/operational/analysis concepts with limited initial assets
- A requirement to train personnel with minimum assets, which implies a centralized training facility
- A need to build up direct linkages to the operational elements of EMC community in order to become maximally responsive and efficient
- A requirement for common direction of all assets--such as engineers, technicians, analysts, equipments, procurements, logistics, funding and staffing requirements, etc.

Since the new mission requirement increases the need for CEEIA on-site measurements on a world-wide basis, it may be desirable to decentralize the organization to some extent after the routine survey capability has been accomplished in prototype form, but this should not be done without careful consideration of resultant costs and other pertinent factors.

3. Interface

The concept discussed here is for CEEIA to greatly increase its direct interfaces with the rest of the EMC community. First, CEEIA EMC management should study the interfaces defined in this report as well as others which they may define. Next, the existing interfaces should be strengthened and appropriate new interfaces should be established. Many EMC problems are solved at least in part through coordination with and knowledge gained from these interfaces. Individuals within CEEIA EMC management should be asked to take the lead in establishing and maintaining specific interfaces on behalf of CEEIA management (while carefully coordinating with STRATCOM headquarters).

The Tempest Program, for example, has gone through a learning experience while establishing routine surveys pertinent to the Tempest mission. Hence, Tempest management personnel should be able to share some of their lessons learned with CEEIA while CEEIA is planning its routine surveys program. The MIJI program can provide an identification of Army RFI problems to STRATCOM. The radiation hazard program also presents a useful interface. This program should be able to provide CEEIA with information on the electrical and environmental parameters most usefully measured.*

4. Educational

The educational requirements were specified in Section IV-E; the discussion here focuses on the concept of an educational plan, for both CEEIA personnel and site personnel.

An educational plan for CEEIA personnel might include the standard approaches of attendance at conferences (e.g., the annual International EMC Conference) and symposia, making technical literature (e.g., IEEE Transactions on EMC) available to the staff, and active participation in technical societies. Also useful may be in-house seminars with visiting scientists and engineers.

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* It should be noted that the Office of Telecommunications Policy (OTP) has organized an interagency program on the effects of non-ionizing radiation as a follow-up on the side effects study given in Ref. 7. It is expected that this program will receive substantial funding beginning with FY 74. Information on this program can be obtained from Mr. D. M. Jansky of OTP.

An excellent vehicle for education of site personnel is the new CEEIA mode of operation involving routine surveys in addition to QR tasks.

This vehicle might be employed in the following ways:

- Have EMC educational materials developed for use by the CEEIA routine survey teams while on site
- Employ displays of local EMC problems (e.g., oscilloscope, spectrum analyzer, or frequency-amplitude-time) in demonstrations for the base commander and his staff (including the EMC officer).

Finally, the routine surveys offer an ideal training ground for CEEIA EMC problem-solvers who will also have to perform the more difficult QR tasks.

B. Specific Concepts

To carry out an operational concept and meet the specific requirements of the CEEIA mission, four functional areas must be defined and implemented. There must be (1) a measurement function to acquire EMC data, (2) an analysis function to process the data, (3) a data-base to store the data, and (4) a management function to control the operation and interface with the user community. The interaction of these four functions is discussed elsewhere.

1. Measurement

The measurement or data acquisition function includes all activities required to field men and equipment to make the measurements needed to support both routine and QR surveys. The analysis function should provide a description of the measurements to be made for each survey task, the management function should assign priorities to the tasks, and the measurement function should implement the planned measurements.

The results of the measurements should be analyzed in real-time as they are taken to assure that the data are valid and useful. For routine

surveys the data should be provided to the analysis function which should use it for problem solving, as input to the data-base, and as feedback for new measurement requirements. For quick response, the data should be analyzed in real time and be used to solve the problem or to define new measurements. Thus, the measurement and analysis functions are not readily separated physically. In fact, the same men and equipment taking measurements may also analyze the data.

The operational concept discussed elsewhere implies two distinct types of equipment. These may be conveniently thought of as automatic and manual, although the degree of automation may not be extreme. Conceptually, one set of equipment will include both automatic and manual instrumentation capable of performing the routine <u>and</u> QR response functions. This equipment will be routinely deployed, but preemptible for QR. An additional pool of manual equipment will be available for QR response.

The measurement equipment must meet the requirements for both routine and quick response surveys. Since the latter are more problem-oriented, they are less easily generalized. Our approach has been to determine a basic equipment configuration to meet the routine survey requirements, and then to examine this configuration to determine how it can be modified to meet the QR requirements.

a. <u>Routine Measurement Instrumentation</u>

The basic data to be acquired through routine measurements consists of:

- Field strength as a function of frequency
- Identification and location of emitters of all strong signals
- Characterization of emitters of all strong signals
- Ambient radio noise level at site.

This information, if routinely collected at each site, should provide the required measurement-derived data base.

The field-strength measurement as a function of frequency requires the use of a scanning receiver connected to suitable antennas and recorders. As the routinely collected field-strength measurements are to be used for identification of potential RFI problems for future frequency coordination and allocation, they must be made and processed continuously (in frequency, not time) in the bands of interest at each site. This is a quite different requirement from that being met today, where measurements are made continuously across the band, with only the signals exceeding some threshold being processed. Hence, the scanning receiver should be of the semiautomatic or automatic sweeping type. Manually scanned receivers can be used; however, they will greatly reduce the frequency range which can be covered in a given period of time. Furthermore, manual data acquisition will greatly limit the format and size of the resulting data base.

The routine identification, location, and characterizations of strong-signal emitters require detailed measurements which are very difficult to automate. They are probably best made by an operator-semiautomatic system. For example, the system should be capable of demodulating any type of signal which may be encountered, and the operator should be able to select any of the demodulators at will; however, the system should not be required to automatically measure the modulation-type. Signal parameters such as frequency, frequency stability, bandwidth, pulse width, and pulse repetition rate must all be measurable. The system could be configured to automatically record the results of these measurements, and to perform the measurements with as little operator attention as reasonable. However, system design should proceed using the philosophy that automatic measurement of all signal parameters is not necessarily desired. Careful consideration should be given to the equipment cost and complexity of full automation and consideration be given to less automation and more operator interaction.

A functional block diagram of the basic system for routine surveys is shown in Figure 2. This system consists of the following subsystems:

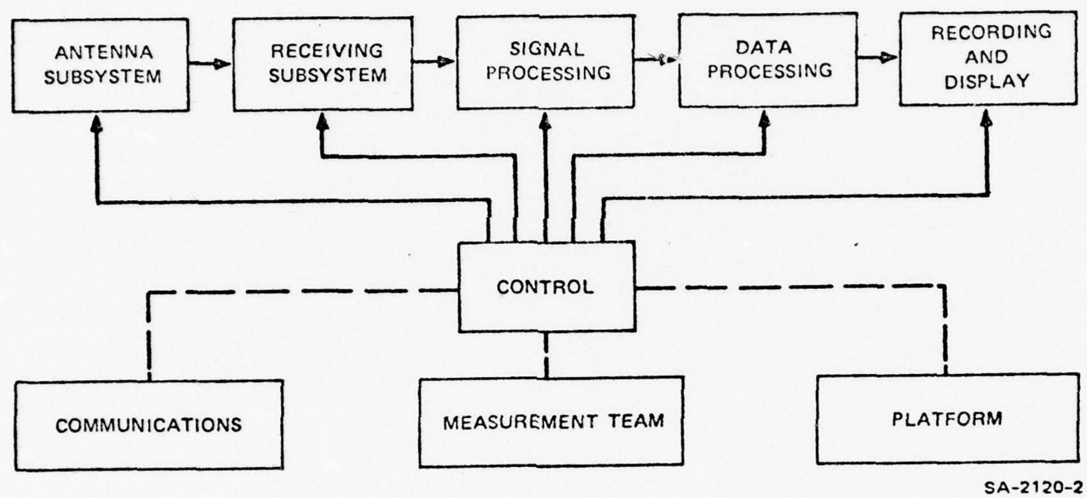

FIGURE 2 FUNCTIONAL BLOCK DIAGRAM OF ROUTINE SURVEY SYSTEM

- Antenna
- Receiving
- Signal processing
- Control
- Data processing
- Recording and display
- Communications
- Platform.

A functional description and the requirements for each of these subsystems are provided below.

Antenna--The subsystem includes the antennas, antenna switches and interconnecting cables, and wave guides to cover the frequency range of present and planned Army C-E plus RFI coverage (approximately 30 Hz to 18 GHz). This subsystem should provide:

- Calibrated, omnidirectional coverage of surveyed frequency band
- Directional coverage for DF
- Capability of band-selection by digital control
- Ease of transport and set up.

Receiving--The subsystem consists of RF and IF amplifiers, oscillators, mixers, and filters needed to scan the surveyed band of 30 Hz to 18 GHz and to select the frequency at which measurements will be taken. It should provide digitally controlled:

- Gain
- Frequency
- Bandwidth (resolution)
- Scan rate
- Band (scan limits).

To provide for semiautomatic measurement of detailed signal characteristics the receiving subsystem should also operate as a tunable filter under either manual or digital control.

Signal Processing--The subsystem consists of detectors, demodulators, spectrum analyzers, and pulse analyzers required to calibrate the system and measure the field strength and detailed signal parameters. This equipment should be digitally selectable and digitally controlled where reasonable, but opportunities for simplifying the equipment by using operator interaction should not be overlooked. For example, it is usually easy for an operator to decide upon the modulation type of an emitter simply by listening to the AM and (or) FM demodulator outputs. This is a very difficult measurement to automate.

Control--The subsystem should probably be a part of a minicomputer. It should have the necessary hardware interfaces and software packages to control the entire system. It should provide for:

- System mode selection (scan, measure, and calibrate)
- Band selection
- Scan parameter selection
- Measurement function control (peak, average, rms, and signal parameters)
- Data processing control
- Data recording control.

The system should be designed to minimize required operator interaction and to facilitate the man-machine interface. The system should have automatic calibration and diagnostic routines.

Data Processing--The subsystem should also contain a minicomputer. A single instrumentation computer with a complement of suitable peripheral equipment (e.g., tape, read-only memory (ROM), and disk storage) has all the capability needed to provide both control and data processing functions. The control subsystem will assure that suitable measurements are input to the data-processing subsystem. The latter subsystem should process the measurements into a form suitable for recording and display, and will consist of the necessary hardware interfaces and software packages to perform this processing.

Recording and Display--The subsystem provides two major functions:

- Recording and display of survey data
- Storage of software packages.

The recording portion of the system should include both a digital magnetic tape and a digital disc. The disc will provide a greatly expanded memory for storage of data which requires rapid access, such as software packages and intermediate data-processing results. With a disc it is possible to rapidly swap programs and greatly expand the ability of a minicomputer to perform the control and data-processing functions. The disc will also provide the flexibility needed for system updating, modification, and expansion.

The display portion of the system should provide for a rapid quick-look at raw data, as well as processed data. It should also provide for hard copy of both graphic and alphanumeric data. This requirement can be met with special-purpose displays such as oscilloscopes and x-y plotters which might be modular enough to be useful as stand-alone devices, or it can be met with a CRT terminal capable of both graphic and alphanumeric display under computer control. An advantage of the CRT terminal is that it could replace the more usual teletype as the operator-system interface. This would reduce the noise level significantly and provide for greater operator comfort.

Communications--The subsystem should provide an ability to communicate with home-based specialists and data base to solve problems as they arise and to obtain data as needed. It can be provided by a mobile telephone and a digital modem suitably interfaced to the computer.

Platform--The platform which houses the survey system should be capable of being quickly transportable to remote sites, and it should have self-motive ground maneuverability once on-site. The requirement for rapid transportability arises due to the need to use the survey equipment in the quick response mode as well as in the routine mode. The ground maneuverability requirement arises from the need to map field intensity controls when performing RFH surveys and from the need for general mobility at remote sites. The platform should provide a controlled environment for the electronic equipment and operators under all extremes of external environment.

A basic system meeting the requirements outlined above will satisfy the need for routine survey equipment. Although it will also be suitable for many of the required QR measurements, it must be supplemented to meet all QR needs.

b. Quick Response Instrumentation

Although the measurements needed for a quick response are basically the same as those required for routine response, the operational situation is often quite different. The measurements for QR are more problem-oriented, and more human interaction is required since the problem is being solved on-site, if possible, and the results of one measurement will suggest other measurements or modify the test plan in other ways. Furthermore, in the QR mode, data recording is performed primarily for on-site analysis and documentation. Often in QR much less data are taken and the requirement for automation of data recording is greatly reduced. Thus, it is possible to configure less costly manual equipment to supplement the more automatic routine equipment. The combination of automatic or semiautomatic routine response equipment and manual quick response equipment should be much more cost effective than a configuration using only automatic equipment.

The equipment required for the QR mode is basically a modernized version of equipment currently being used. Emphasis should be placed on obtaining small, easily transportable battery-operated manual instrumentation such as receivers, spectrum analyzers, and oscilloscopes. Particular attention should be paid to the human-factor aspects of the equipment. Environmentally related factors also must be taken into account.

2. Analysis

The analysis function includes responsibility for analysis of routine survey results to identify potential problems, analysis of requests for QR surveys to determine the required response and measurements, analysis of data acquired during surveys, synthesis of the results into data-base updates, and recommended solutions to problems. This function should be the primary interface with both the data base for input/output and the measurement function for data acquisition.

All necessary analysis personnel and facilities should be within CEEIA. This function may be either centralized entirely or dispersed to the different regional centers. If it is dispersed so that each regional center has a semiautonomous analysis capability, it will be possible to respond more rapidly to QR requests than if it were centralized since personnel will be available on-the-spot and will have specialized, detailed knowledge of regional problems. Highly specialized analytical capabilities as needed for all regions, but not routinely, might be pooled at a central headquarters and drawn upon as needed. Even in this situation, a dispersed analysis function will have certain drawbacks: it will require redundancy in routine analysis capability, it will require redundant data-base access means, and it will probably be difficult to manage efficiently unless the management function is also dispersed.

Alternatively, if the functional capability is entirely within a single center, the redundancy will be eliminated, data-base access will be simplified, and management will be easier. Reaction to nonroutine problems will probably be slower due to the travel time and the need for personnel to become familiar with regional problems not identified by routine survey.

Often a well-trained EMC engineer will be able to provide the required analytical results manually; however, as the operation gradually emphasizes routine surveys, analytical problems will require more and more automated computational power, and the routine data-processing will become more voluminous and more easily automated. Ultimately, the analysis function must include direct and immediate access to a large digital computer. This access may be to a batch processing facility or to a time-sharing interactive facility. In either case, the computer should have resident the necessary analytical tools. This implies that all required propagation, EMC, and environment models be available for ready access. This also implies immediate and direct access to the data base.

It will always be necessary to have well-trained engineers to perform the analysis function. The concept being advanced, arising from the requirement to perform routine surveys, is to provide powerful analytical aids to the engineer and to allow a digital computer to take over the majority of the routine data processing (freeing the engineer for other tasks).

3. Data Base

The data-base function provides for storage and retrieval of all data needed on a routine basis as well as highly specialized data not available outside CEEIA.

This function may reside entirely outside CEEIA if it is organized in such a way as to meet CEEIA needs for both routine and QR surveys. In this case, the communications and data format must be immediately accessible to every CEEIA region. Furthermore, the data base must be organized so that the CEEIA user does not have to sort through excessive amounts of data or process it in other ways to use it. It must also be organized so that it is easily updated with the results of both routine and QR surveys.

Alternatively the function may reside wholly within CEEIA. In this case, it must be connected and organized so that the rest of the EMC community can make ready use of it. This alternative should be considered only if it is not possible to organize and access a suitable data base.

Probably the most viable alternative is to split the data-base function so that the data needed for QR problems are maintained either as a separate QR portion of an external data base with extremely rapid access by CEEIA or as a small special-purpose data base within CEEIA.

The data base should contain the elements described in Section V-C. The data base is currently manually accessed and maintained. As more data are collected, and the routine data are accessed for routine or QR response, the requirement for an automated data base will grow. Ultimately, it will be necessary to provide an automated data base with rapid access teleprocessing facilities.

4. Management

To meet the requirements of the expanded CEEIA mission, the management function within CEEIA must be strengthened, and its role expanded.

Requirements include planning, scheduling, coordinating and interfacing. Although these activities may be physically dispersed, they should be controlled centrally to assure smooth functioning. The chain of command from management to measurement, analysis, and data-base functions should be direct. Responsibility and authority in these areas should be clearly defined.

VII IMPLEMENTATION CONCEPT

In previous sections we have made an initial analysis of the requirements that CEEIA must satisfy to meet their redefined mission. Clearly, a much more detailed look at each element of the CEEIA program is needed to assure that CEEIA can meet their obligations in the DoD EMC program.

Figure 3 shows the flow of the major elements of an implementation concept. Initially, a careful analysis of documentation that describes the CEEIA mission should be performed with particular attention to clarification of any ambiguities or overlaps with other elements of DoD. With a clear view of its mission in the EMCP, CEEIA should next define and analyze their mission requirements.

The basic mission objectives have been defined in Refs. 1-5 (see also Sec. III), while the general and specific requirements of CEEIA should be defined and analyzed in more detail than has been possible in this report. Basically, we have initially defined a need for operation, organization, and management plans together with a need to develop measurement, analysis, and software/data base capabilities. It is conceivable that other requirements need to be defined and that the definitions of the initial set of requirements need to be expanded and (or) modified.

The initial operation, organization and management concepts described in this report are those needed to provide an initial incremental step from QR work to a combination of QR and routine work. We believe, based on current inputs, that an initial concept of a centralized CEEIA EMC capability is meaningful because of problems of logistics, cost, training, equipment, etc. It is likely, however, that the increased demands on CEEIA that result from their expanded mission may argue for a regionally operated/organized/managed capability at some future time. This option for evolution should be evaluated and data should be developed on the costs and benefits of each option (centralized or dispersed) to facilitate a reasonable analysis at a later date.

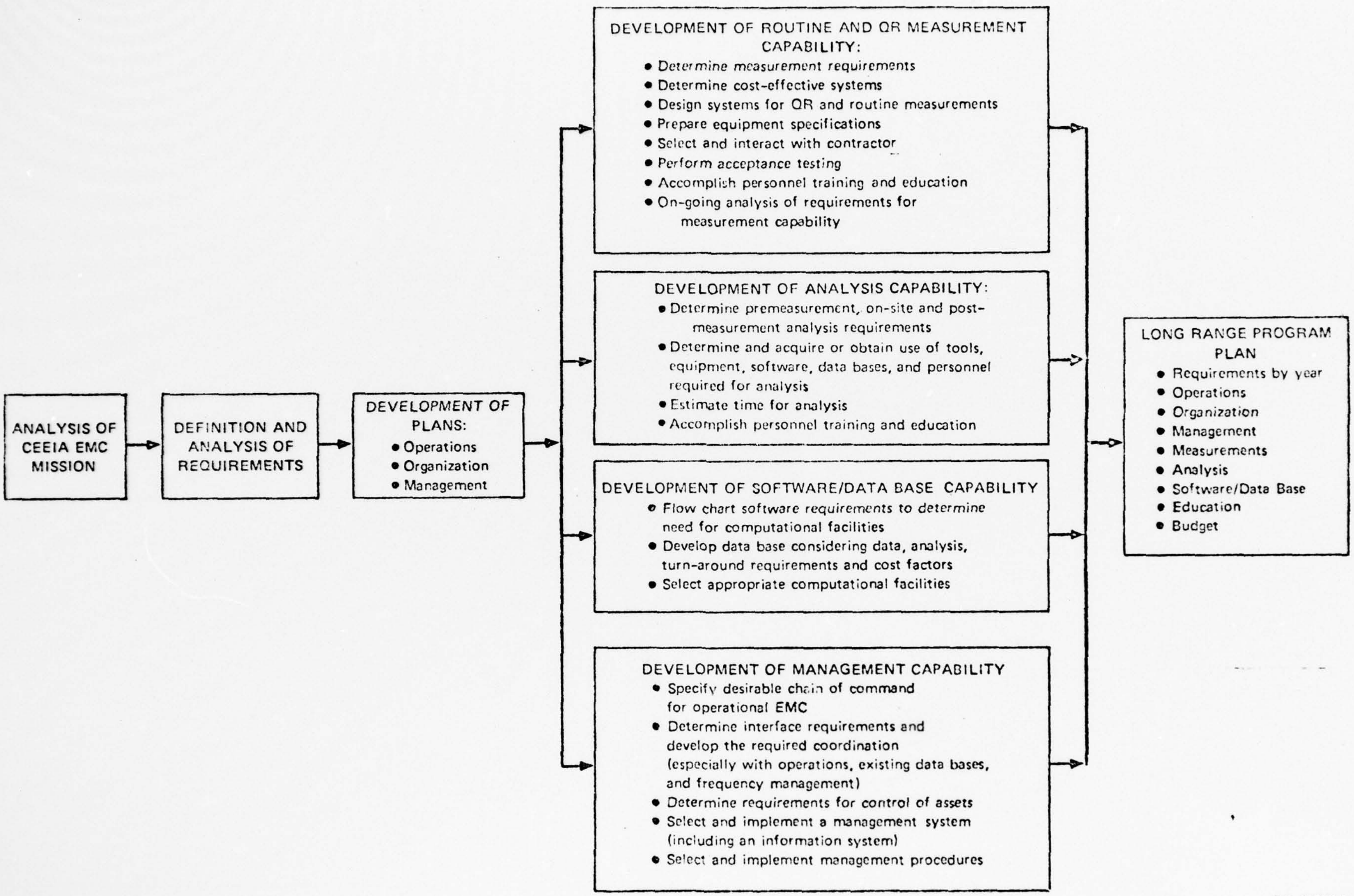

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FIGURE 3 CONCEPT FOR IMPLEMENTATION OF A LONG RANGE PROGRAM PLAN

In Fig. 3, we have provided a fairly detailed listing of tasks that must be accomplished to achieve adequate measurement, analysis, and software/data base capabilities. An accurate determination of the needs for each of these capabilities should be made. As discussed above, the needs can be expected to continually evolve and CEEIA must do some long-range planning to assure that these relatively costly capabilities, together with the personnel required to achieve them, are entered into budget cycles and personnel acquisition.

Because of the evolution of both C-E and measurement equipments, it will be necessary for CEEIA to continuously match their needs for measurement equipment against the technical and operational characteristics of the C-E equipment. This will assure that the measurement equipments can adequately document the EMC-related parameters of all C-E equipment they will encounter. Other critical tasks pertinent to determining the on-going measurement equipment requirements are shown in Fig. 3.

Analysis requirements, like measurement requirements, can be expected to continuously evolve as the C-E equipment and the needs of the EMCP evolve. These needs must be met by determining the tools (see Fig. 3) that are required for analysis and where and for what duration they must be employed. For example, digital recording, processing, and analysis should be considerably expanded for CEEIA to reach its program goals. This means that CEEIA should expand their data processing/analysis staff at a rate commensurate with their requirements.

Currently, the software and data base capabilities of CEEIA appear to be limited. Following an analysis of the requirements for computational support, software and data bases should be developed to support the measurement and analysis requirements. Existing analysis and data base facilities, such as the Electromagnetic Compatibility Analysis Center (ECAC) and the Army's Communications-Electronics Computer Applications Agency (CECAA), should be used whenever possible. CEEIA should develop their own capabilities only as required to fill gaps that are identified in the ability of such facility capabilities to satisfy CEEIA's

requirements. Important factors--such as turnaround time, tasking mix (QR versus routine surveys), availability, cost, etc.--must be evaluated to determine which facilities should be used to support the CEEIA mission.

These various elements of the implementation requirement should be melded into a long-range program plan that is time-phased to meet CEEIA's long-term objectives. We believe that this concept for program evolution will, if properly developed, permit CEEIA to fulfill their EMCP mission.

VIII RECOMMENDATIONS

The recommendations that follow are based on our analysis of the CEEIA EMC mission. The recommendations are divided into two groups--short-term and long-term. Short-term recommendations are those required to begin the process of evolving a viable CEEIA program to meet the EMCP program objectives. Long-term recommendations are those required to assure that the CEEIA operational EMC program meets the long-term demands of operations, management, equipment, analysis, data base, and budget requirements.

A. Short-Term

The following short-term recommendations are based upon material presented in detail in the earlier sections of the report and represent our conception of the most important short-term actions that CEEIA should initiate:

- Develop an initial instrumentation capability to perform the routine measurement/survey function.
  - Provide a limited initial automated capability to include automatic frequency scanning and logging of amplitudes as a function of frequency.
  - Provide for expansion of automated capability as needs develop. To provide this capability, the antenna, receiving, control, data processing, recording and display, and communications subsystems should be modular and easily upgradable for added automated capability.
  - Determine and provide computational capability in the system for required on-site analyses.
  - Initiate organizational and management functions required to support the measurement capability. This should initially be a centralized function.
  - Begin training of personnel in operational techniques for semiautomated digital systems.

- Develop requirements for control software for van operation.
- Develop specifications for semiautomated, modular system with required antenna, receiving, control and analysis, display, recording, communications, and platform subsystems. Also, specify packaging, self-EMC restrictions, expandability, and modularity.

• Augment quick response capability
  - Quantify measurement requirements for quick response capability.
  - Determine extent of data recording and analysis required for generic QR operations.
  - Survey available QR assets to determine their capability to fulfill QR mission. Consider problems of transport, time required for use, ability to match performance of C-E equipment, utility of data for analysis, data recording, data reliability and repeatability, statistical validity of results, etc.
  - Identify requirements for new QR equipment by matching utility of current equipment with CEEIA mission.
  - Purchase small, easily transportable, battery-operated, manually-controlled instruments--such as receivers, spectrum analyzers, oscilloscopes, portable calculators, digital data recording VTVM, etc.--as required to meet mission requirements.
  - Consider human factors, environmental factors, modularity, multipurpose capability, etc. in equipment selection.

• Develop analytical capability
  - Establish analysis requirements for premeasurement, on-site, and postmeasurement situations.
  - Determine requirements for personnel and equipment (computers, calculators, references) to perform analyses.

- Identify sources of analytical capability in CEEIA, STRATCOM, ECAC, CECAA, etc. and determine their availability.
- Establish working plan for accomplishing the required analyses at all identified facilities.
- Begin acquisition and training of CEEIA personnel to perform required analysis tasks.

• Develop data base/software
  - From requirements for data and analysis, determine data base elements and software required for analysis.
  - Determine size of data base and its location(s).
  - Establish plans for data base maintenance at selected facilities (as determined above in analysis program).
  - Task identified elements to begin preparation of software to analyze operational EMC data obtained by CEEIA.

• Establish an operationally oriented and directed EMCP management function.
  - Strengthen the current EMC management function within CEEIA commensurate with the new requirement to add routine survey measurements to the current load of QR problems.
  - Determine the impact on management function of expanded measurement mission. Consider requirements for interfaces, control of expanded assets, evolving planning function, multiple system control, etc.
  - Initiate management function on a central basis with considerations for regional management as problems of logistics, training, command and control, cost, personnel motivations, etc. are assessed.
  - Attempt to simplify, if feasible, the CEEIA management chain so that operational EMC problems are controlled by operational Army organizations.

- Greatly increase interaction of CEEIA personnel with remainder of EMC community. Pursue objectives of mutual support, data base validity, common program goals, etc.

• Develop organizational and operational plans.
  - To facilitate CEEIA's accomplishment of its operational EMC mission, establish as direct a linkage as possible between the CEEIA EMC problem solvers and the operational entities who have the problems.
  - Provide an initial central organizational and operational concept.
  - Determine categories of personnel required for meeting expanded CEEIA EMC program requirements.
  - Organize (and acquire as required) personnel to meet survey and QR modes of operation.
  - Arrange for engineers and technicians performing EMC tasks to be organizationally arranged as closely as possible.
  - Provide an operational plan to train, control, and optimally employ personnel for survey and QR tasks.
  - Determine best deployment of personnel and equipment to optimize measurement effectiveness and crew performance, motivation, and morale.

B. Long-Term

The long-range recommendation was partially addressed in Section VII. Basically, CEEIA should, to the extent practical, engage in a planning exercise which will assure their ability to fulfill their operational EMC mission. Only CEEIA is in a position to accurately identify their own equipment, analysis, procedural, management, operational, data base, and other needs. Organizationally, they must be capable of identifying and fulfilling those needs on an on-going basis. Essentially, then, our long-term recommendation

is that CEEIA establish a long-range plan that is periodically reviewed and serves the purpose of maintaining the required CEEIA capability in the EMC program over a long period of time.

Appendix

STATEMENT OF WORK FOR CURRENT TASK

The following statement of work was provided to SRI on 7 August 1972:

SUBJECT: Procurement of Non-Personal Engineering Services to Provide Assistance for USACEEIA in the Electromagnetic Compatibility Program (EMCP) within the US Army

This agency is in the process of evaluating its role and responsibilities in the USASTRATCOM EMCP. This evaluation includes the determination of field survey equipment requirements to meet agency responsibilities.

STATEMENT OF WORK:

1. Scope of Work

The contractor shall furnish scientific and engineering non-personal services to US Army Communications-Electronics Engineering Installation Agency in the evaluation of specific agency responsibilities in the Electromagnetic Compatibility Program.

2. Description of Functional Task Areas

a. Requirements Analysis - Develop an appreciation of the total requirements of the EMCP placed upon USACEEIA with particular emphasis on the field survey and data collection/evaluation aspects of the program.

b. Based upon the above analysis, develop a concept and philosophy of use for required instrumentation for the USACEEIA field survey capability. Items of concern should include but not be limited to the following:

(1) Types of measurements to be taken

(2) Length of measurement

(3) Geographical service areas

(4) Major systems or activities served

(5) Measurement equipment requirement for spectrum or environmental test

(6) Frequency range coverage

(7) Transportability and deployment method

(8) Environmental operating restrictions

(9) Method of compiling survey data

(10) Disposition of survey data

c. The completion of the concepts and philosophy of use will provide the necessary basis for the final service requirement: to develop an equipment system(s) design considered adequate to support the USACEEIA field survey responsibility within the USASTRATCOM EMCP.

REFERENCES

1. DoD Directive 3222.3, "Department of Defense Electromagnetic Compatibility Program" (5 July 1967).

2. Army Regulation No. 11-13, "Army Electromagnetic Compatibility Program" (29 July 1969).

3. Army Regulation No. 10-13, "United States Army Strategic Communications Command--Organization and Functions" (23 November 1971).

4. USASTRATCOM Supplement to AR 11-13, "Army Programs--Army Electromagnetic Compatibility Program" (5 June 1970).

5. "Electromagnetic Compatibility (EMC) Plan for Implementation of the USASTRATCOM Electromagnetic Compatibility Program (EMCP)" (14 April 1972).

6. G. H. Hagn, S. C. Fralick, H. N. Shaver, G. E. Barker, "A Spectrum Measurement/Monitoring Capability for the Federal Government," Final Report, Contract OEP-SE-70-102, SRI Project 8410, Stanford Research Institute, Menlo Park, California (May 1971).

7. The Joint Technical Advisory Committee, "Spectrum Engineering--The Key to Progress," Institute of Electrical and Electronic Engineers, New York (March 1968).